

Does governance create political risk?

- The case of investment decisions in agriculture

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Summary

This thesis seeks to address how political risk influences investment in the agricultural sector in Norway. The agricultural sector is a particularly interesting case as it is highly affected by governmental intervention. Governance is aimed at establishing predictable and stable production terms, and an important question in this context is whether governance is able to reduce the overall risk faced by farmers. For example, the politically determined target prices for milk, aims at reducing the overall risk of dairy farmers, but they could also provide a false sense of security. A farmer in a free market will be exposed to price risk. A farmer in Norway will not be exposed to price risk in the same way because prices are more or less determined once a year in the agricultural negotiations. However, due to governmental intervention in Norway, the farmer will be more vulnerable to political risk than the farmer in the free market. One could therefore potentially argue that the overall level of risk is not reduced, but that the source of risk is different.

In order to analyse the effect of political risk, I will look at aggregate investment in the agricultural sector and use two proxy variables for political risk. These proxies are the time-period of a parliamentary election and the time-period where a new government is elected.

The theoretical foundation of the thesis will make use of the real option approach in analysing the effect of political risk. Here the value of the real option is linked to uncertainty about the future political framework and the ability to delay an investment decision until this uncertainty is resolved. If political risk is an important risk factor, the farmer may use the option to wait until the outcome of the election is known. If so, investment should be lower in the time before an election or in the time before an expected change in government compared to the time afterwards.

The empirical part of this thesis is based on data from the Norwegian quarterly National Accounts (Nasjonalregnskapet) published by SSB, Farm Account data (Driftsgranskingstall) and the Aggregated Accounts for Agriculture (Totalkalkylen for Jordbruk) both published by NILF. These data sources will be used in order to analyse if variations in risk impact investment and the datasets contribute to the analysis in different ways. The Norwegian National accounts give quarterly data on investment that makes it possible to analyse if there is a drop in investment in the quarters before an election. The Aggregated Accounts allow us to analyse whether the type of investment and the depreciation rate influence the option value.

Farm Account data on the other hand; enable us to look at the effect of increased risk in one specific sector.

The hypothesis that political risk influences investment has been tested with two different econometric specifications, given by the autoregressive conditional heteroscedastic (ARCH(1)) model and ordinary least square regression. The ARCH model specification measures if any of the dummy variables for risk influences the volatility of investment. The results indicate no conclusive evidence to support the hypothesis. The least square regression specification analyses whether political risk influences the investment level. While I do find support for the dummy variable on election of new governments on a 10 % significance level in the Farm Account dataset - the significance is weak and the results are not confirmed in other specifications.

I find no conclusive evidence for political risk influencing neither the volatility of investment nor the investment level. This indicates that, given the data and the methods used in this study, political risk does not significantly influence producer behaviour in the agricultural sector. This could be interpreted as the agricultural sector being well regulated and that political conditions are relatively stable across different and changing governments, as well as over different party constellations in Parliament.

Preface

This thesis has been written in collaboration with the Norwegian Agricultural Economics Research Institute (NILF) under the supervision of Klaus Mittenzwei. Writing this thesis has been a great experience and has awakened a newfound interest in me for the field of agricultural economics.

I would like to thank my supervisors, Kjell Arne Brekke from the University of Oslo and Klaus Mittenzwei from the Norwegian Agricultural Economics Research Institute especially. This thesis would not have been possible without your useful ideas, input and steady guidance through a process that at times has been straining.

Thank you also to Ragnar Nymoen at the University of Oslo for his input and comments on the ARCH modelling.

Furthermore, I would like to thank NILF for providing office space, scholarship and all the NILF staff for a rewarding professional environment and assistance.

Thanks must also be given to the members of Friends of Econometrics for useful discussions and comments. Thanks to Bjørn Gjerde Johansen for helping me understand some of the technicalities in the models and to all near and dear friends at the University of Oslo.

All remaining errors and weaknesses are my own responsibility.

Silje Undahl, May 2014

Table of content

1	Introduction	1
1.1	Background.....	1
1.2	Proxy variables for risk.....	2
1.3	Politics and agriculture	3
1.4	Government controlled production and political risk.....	6
2	Theoretical foundation	7
2.1	Theories of investment under uncertainty	7
2.2	Problem description.....	10
3	Data and method.....	11
3.1	Data from Norwegian National Account.....	11
3.1.1	ARCH(1) model estimation.	14
3.1.2	Alternative specification.	16
3.2	Aggregated Account for Agriculture.....	18
3.2.1	Investment in buildings	20
3.2.2	Investment in machines	20
3.3	The Farm Account Data	21
3.3.1	Sector specific investment.....	22
4	Results	23
4.1	Results ARCH model	23
4.1.1	Alternative specification of ARCH	25
4.2	Results Aggregated Account buildings.	26
4.2.1	Results Aggregated Account machines.....	27
4.3	Results Farm Account data.....	29
5	Discussion	30
5.1	Discussion of regression results	30
5.2	Discussion of model specification.....	33
5.2.1	Misspecification of the model	34
6	Conclusion.....	37
	Appendix A: Data on producer support	38
	Appendix B: OLS assumptions	39
6.1.1	OLS assumptions Norwegian National Account	39

6.1.2	OLS estimation the Aggregated Account.....	42
6.1.3	OLS assumptions Farm Account data.	47
	Bibliography.....	49

1 Introduction

1.1 Background

In 2005, Flaten, Lien, Koesling, Valle, & Ebbesvik conducted a survey to analyse the perception of risk among organic and traditional farmers in Norway. The study showed that dairy farmers considered the risk associated with future subsidies to be more important than the risk of, for example fluctuating prices. Surveys can uncover *how* producers in the agricultural sector perceive risk, but we do not know whether this has an actual effect on producer behaviour or not. It might be that even though producers *perceive* political risk to be an important risk factor, this perception may not lead to an actual change in their behaviour. However, an increasing amount of evidence supports the general hypothesis that political risk influences investment decisions¹.

The purpose of this thesis is twofold. First, it will establish a theoretical foundation for analysing the effect of political risk on economic behaviour. In this regard, the main novelty of this thesis is the application of the real option approach to investigate political risk in the agricultural sector. Second, it will test the hypothesis that political risk influences producer behaviour by looking at time-series data on investment.

Hegrenes et al. (2008), Bergfjord & Brandt (2009), Bergfjord (2007) and Lien & Hardaker (2005) give important contributions on the effect of political risk on agriculture. In the NILF rapport, Risk exposure and Risk Management, by Hegrenes et al; attitudes towards risk and risk coping strategies in agriculture and aquaculture were analysed. The working paper by Bergfjord (2007) is a theoretical analysis of prediction markets as a toll tool for managing political risk. The model is theoretical and much research is needed before markets on risk can be used to spread risk in practice. The work by Bergfjord and Brandt (2009) reviewed the relationship between risk, regulation and rent seeking behaviour. This article studies how political risk affects rent-seeking behaviour. They find that there is an optimal level of risk where the marginal increase in risk is equal to the marginal reduction in the cost of lobby. Thus, some risk can be desirable because it may discourage rent seeking.

¹ Alesina & Perotti (1996) show that uncertainty in the political-economic environment reduces investment. Alesina, Ozler, Roubini, & Swagel (1992) have investigated cross-country differences between political instability and GDP per capita growth and find a positive correlation between government collapse and growth. Knack & Keefer (1995) show that indicators of uncertainties in property rights enforcement are negatively associated with private investment performance across countries.

The contribution of this thesis is to analyse if the risk perceived by farmers influences producer behaviour. While previous research has established that farmers believe political risk to be an important risk factor, it has not been established whether this perception has a real influence on their economic behaviour. Production in the agricultural sector in Norway is in many ways regulated by government². Hence, research on how political risk affects economic behaviour is important. No normative conclusion can be drawn based on this thesis. Even if one can establish that political risk does influence investment - that does not entail that policy should be implemented to reduce risk.

1.2 Proxy variables for risk

The perception of risk is unobservable. While many farmers can give examples of isolated incidences where they feel that the political framework has greatly influenced their economic behaviour - feelings are subjective perceptions and do not prove that the political framework has in fact had a quantifiable influence on their economic behaviour. To measure the impact of political risk on investor behaviour I will therefore need a proxy with exogenous variation. For this purpose, I have chosen to use the election of new governments and general elections.

For a proxy to be valid, it should only influence the dependent variable through the proxy chosen. The proxies for political risk are general elections and the election of new governments. The proxies chosen represent the *time-period*³ (i.e. the quarter or the year) of the proxy variables. The question is therefore: will these time-periods be exogenous to the level of investment or can they influence investment in other ways than through farmers' expectations. I would argue that they cannot. An election does not change what is happening here and now. It influences what might happen in the future. An election influences expectations through what a farmer thinks of what parties are saying in their campaigns, through what they believe will happen in the future or how the outcome of the election can influence future production. Elections therefore do not change what is happening today, they influence the farmers expectation of what might happen in the future.

² See section 1.3 for more on political governance.

³ Information on general elections and election on new governments has been found on http://no.wikipedia.org/wiki/Liste_over_Norges_regjeringer ; <http://no.wikipedia.org/wiki/Stortingsvalg>

I would argue that this will also hold for the election of a new government, following the same logic as above. Even though a new majority government theoretically could agree on new policy immediately, that does not seem plausible. Policy, politics and reform take time so the election of a new government does not influence the here and now. It influences our expectations of what might happen in the future. On this basis, I would argue that the proxies are indeed exogenous to the investment level.

The next step in deciding whether the proxies chosen are good enough is to discuss if they are relevant. The decision to invest depends on the expected return of investment. Expectations about the future is therefore relevant. As discussed in chapter 1.4, government heavily intervenes in the agricultural sector in Norway. If parties' policies on agriculture did not differ, then the composition of parties and members of government would not matter. However, there are differences in policy⁴ and there are differences on how policy is perceived among farmers. Since government decide production terms, it is likely that the election of a new government or parliament can influence producer expectations. If farmers expect better production terms in the future, they will invest more and vice versa. It is therefore clear that elections, governments and expectations are closely linked.

1.3 Politics and agriculture

Risk may influence producer behaviour in many ways. Not all aspects of producer behaviour are readily available for analysis and one must identify an aspect of behaviour that will be influenced by risk, that is quantifiable and where data is available. For this purpose, I have chosen to look at farmers' investment behaviour. The reason for this is that there is vast literature providing evidence that risk does in fact influence investment in general⁵. There are many data sources on investment and there is data allowing me to differentiate between different types of investment.

In order to explain how investment and political risk is related, two points should be made. 1) If political risk is an important risk factor, farmers may, according to the real options theory

⁴ There are great variations on agricultural policy between parties and the Norwegian Farmers' Association (Norsk Landbrukssamvirke) has a comprehensive review over stated policy on a variety of matters on their website. <http://www.landbruk.no/Naeringspolitikk/Partienes-politikk-2013-2017#.U1ZqZFegUW4>

⁵ For example the Capital Asset Pricing Model (French, 2003) and the Real Options Approach (Dixit & Pindyck, 1994)

discussed in section two, delay an investment decision in order to collect more information on the future political framework. 2) After an election, farmers will know how many seats a party has won in the election and they can formulate expectations based on stated policy programs and partisan strength. However, political risk will not be resolved until they know the outcome of the formal agricultural negotiations, described in section 1.4. The agricultural negotiations are normally held in the second quarter of a year. About half a year will therefore pass between the election date and the negotiations. If the hypothesis stated here is true, I would expect to see a decline in investment in the time before an election and up until the agricultural negotiations in the spring of next year.

Before going further into the analysis, I will provide a graphical illustration depicting investment data, general elections and the election of new governments. This illustration should by no means be taken into account as evidence for the hypothesis. It merely portrays the effect I am looking to find and illustrates whether the hypothesis that political risk influences investment seems *reasonable* or not.

Figure 1 shows gross investment in 2005 prices. The investment data displays great variations in investment over time, which is a good starting point for an analysis. If there were little variation, it would be difficult to analyse the effect of an exogenous shock.

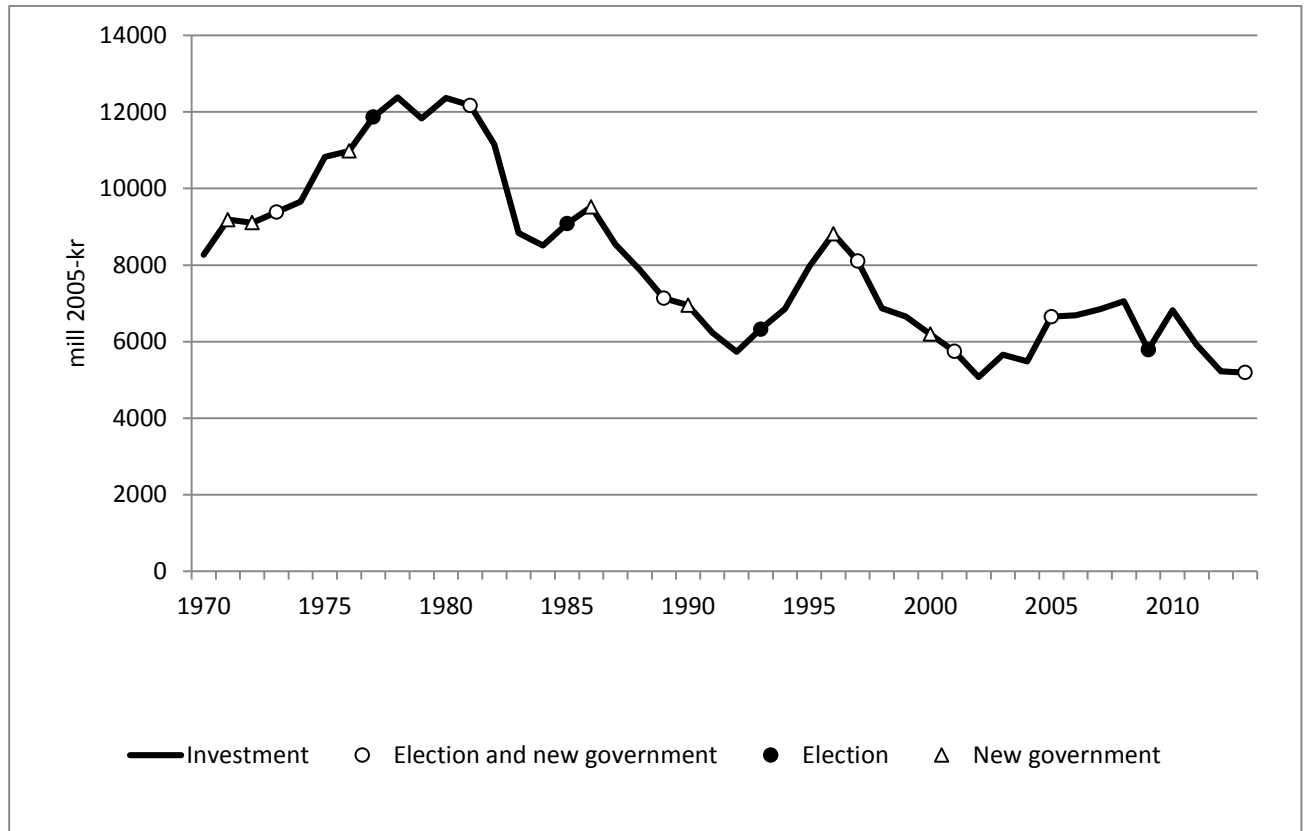


Figure 1 Gross investment in agriculture and forestry from 1970-2013 (SSB) and dummy variables.

For my purpose, some periods are of particular interest. For example, in the years of 1981, 1989, 2005 and 2013, Norway held general elections and elected new governments. This is depicted by a hollow circle in the graph. Looking at the year 1981, we see that investment increases in the time before the election. During the election campaign, there is a slight drop in investment and the graph flattens. After the election, investment starts to decline. This could be considered to be “an option to wait effect” where farmers opted to wait and see the outcome of the election and the agricultural negotiations, before making an investment decision. In addition, if we look at the year 1989, we see that investment declines before the election. In the aftermath of the election, the graph flattens, before investment after a while starts to decline. Farmers optioning to “wait and see” to see the outcome of the agricultural negotiations described in section 1.4 could potentially explain this effect.

Similar arguments could be made for the election of 2005 and before the election of 2013, so the hypothesis that political risk influences investment does seem plausible. There are some

breaks in trend investment that coincides with the election of new governments and general elections, but further analysis is needed before any conclusions can be drawn.

1.4 Government controlled production and political risk.⁶

The structure of Norwegian agricultural policy makes farmers heavily dependent on the political framework and political risk can theoretically be an important determinant in production. An important question in this context is if risk exposure is reduced by politically controlling production terms, or if it provides a false sense of certainty.

The Basic Agricultural Agreement (Hovedavtalen i jordbruket) drawn up in 1950 forms the main legislation regulating the agricultural sector in Norway. Parties to the Basic Agreement are the two main farmers' associations, The Norwegian Farmers' Union (Norsk Bondelag) and the Norwegian Farmers' and Smallholders' Union (Norsk Bonde-og Småbrukarlag), which have the right to negotiate with the government in the annual agricultural negotiations. The negotiations start with the farmers publishing their official demands. The government then presents a first offer and these two documents establish the foundation for the agricultural negotiations. The government has superiority in the negotiations. Therefore, if negotiations break down, the government's offer will be sent to Parliament where the government's offer will usually be approved. Whether the negotiations end in breach or consensus, the final agreement is ratified in Parliament.

The agriculture negotiations have seen a significant expansion over time in Norway. The number of measures in agricultural policy has been widened, which has also led to the agricultural sector having a greater opportunity to influence the content of this policy and making farmers more dependent on the political framework.

The purpose of the Basic Agreement is to lay down target prices for domestically grown agricultural products, as well as to determine the level of fiscal support and direct payments distributed based on region, size of farms, number of animals and more.

⁶ Chapter 1.3. is based on the publication by (Steen, 1988) and the article (Røynde & Gjerdåker).

2 Theoretical foundation

2.1 Theories of investment under uncertainty

The most common method to evaluate the profitability of investment projects is net present value analysis (NPV). This method implies that investment decisions be made by looking at future, expected cash-flows which are discounted to reflect underlying uncertainty⁷. For a given sunk cost of investment, standard present value analysis compares the discounted present value of expected profits, V , with the sunk cost of investing I . Thereby giving a trigger value of $V=I$.

However, if investment decisions can be delayed, the neoclassic rule where investment should be undertaken if $NPV > 0$, will no longer hold. Instead, the timing of the investment becomes a decision variable in itself. A farmer in a real world setting will frequently have a flexible investment decision. He can option to delay an investment decision: he can enter or exit a market; he can option to scrap old milking equipment, to delay the building of a new barn and more. This flexibility can affect a farmer's revenue and excluding this flexibility will systematically underestimate the profitability of investment his projects. Trigeorgis (1998) therefore argues that the real options value should always be included when evaluating the profitability of an investment project. In accordance, the optimal trigger value for investment under uncertainty will no longer be $V=I$, as under NPV analysis, but by $V=I + O$ because of the option value of waiting (assuming a positive option value O). (McDonald & Siegel, 1986), (Dixit & Pindyck, 1994).

To get an idea of the difference between NPV analysis and option theory we will look at an example. Assume that a risk neutral farmer has to decide whether to invest in more advanced milking equipment. If he invests, he will increase the value of the capital stock by $K=100$. This increase in the capital stock will be implemented instantly. Assume further that there is a constant depreciation rate of $\delta=10\%$ and a sunk cost of investment given by $I=650$. In this

⁷ The direction of correlation between investment and risk not clear, and some authors argue that uncertainty can have the opposite effect, and actually lead to an increase investment. One example is given by (Slade, 2013) who in the article investment and uncertainty with time to build, showed that other factors such as long-term planning perspectives in building may in fact lead to an increase investment. Even though correlation is not clear, most literature on option theory predicts a reduction in investment when risk increases.

model there is uncertainty over which outcomes will be realized in the agricultural negotiations. This uncertainty will be resolved at $t=1$ and is binomially distributed with the subjective probability $q=0,5$. A favourable outcome $m=1$ might be that a new government will allow larger milk quotas so that the farmer can earn higher profits. The favourable outcome will increase the value of his investment by 20%. As for the unfavourable outcome $m=2$, this could be that a new government will reduce milk quotas which will decrease the value of investment by 20%.

The formula for calculating the NPV is given by equation 2.1⁸.

$$NPV = I - K \left[\sum_{t=0}^{\infty} \frac{(1-\delta)}{(1+r)^t} \right] = K \left[\frac{1+r}{r+\delta} \right] - I \quad 2.1)$$

Assuming a risk-free interest rate of $r = 5\%$, the net present value of investing immediately is.

$$NPV = 100 \left[\frac{1+0.05}{0.05+0.1} \right] - 650 = 50 \quad 2.2)$$

As traditional $NPV > 0$, the neoclassical investment theory dictates that the investment should be undertaken. However, this might be a mistake as the calculation above ignores the opportunity cost of waiting to see what the outcome of agricultural negotiations are. To highlight the effect we can calculate the NPV for $m=1$ where the value of the investment is increased by 20 % (equation (2.3)) and $m=2$ where the value of the investment decreases by 20% (equation (2.4)). The net present value is discounted by one year as it entails the farmer waiting one year to invest to find out the outcome of the agricultural negotiations.

$$NPV = \frac{0.5}{1.05} \left[100 \times 1.2 \left[\frac{1+0.05}{0.05+0.1} \right] - 650 \right] \approx 90,5 > 50 \quad 2.3)$$

$$NPV = \frac{0.5}{1.05} \left[100 \times 0.8 \left[\frac{1+0.05}{0.05+0.1} \right] - 650 \right] \approx -43 \quad 2.4)$$

We see that if the favourable outcome should come to pass, the farmer should invest because $NPV > 0$. However, if the bad outcome comes to pass, the farmer should not want to invest

⁸ The framework for the NPV analysis is based on (Dixit & Pindyck, 1994) Chapter two.

because $NPV < 0$. This is also an illustration of Bernake's so called "bad news principle" (Dixit & Pindyck, 1994) which states that it is the ability to *avoid* the consequences of bad news that leads us to wait. Therefore, the option value will be contingent on good news.

The example clearly shows that exercising the option to wait is better than investing right away. The opportunity cost of investing right away in this example will be given by the difference between the NVP in equations (2.2) and (2.3) which is $90.5 - 50 = 40.5$. In other words, we would be willing to spend a pay-off of 40.5 in order to have a flexible investment opportunity. Since there is an opportunity cost of investing, the full cost of investment will be the investment cost plus the opportunity cost i.e. $650 + 40.5 = 690$. The additional 40.5 is the option value over the NPV value that represents the risk premium created by uncertainty.

In order to quantify how valuable this flexibility is, we can calculate the level of sunk cost investment that will make the farmer indifferent between investing now and optioning to wait. In order to do this we will equate the expected NPV of waiting given by equation (2.3) and the NPV of investing immediately (2.2).

$$NPV = \frac{0.5}{1.05} \left[100 \times 1.2 \left[\frac{1+0.05}{0.05+0.1} \right] - I \right] = 50 \quad (2.5)$$

Solving this equation for I yields $I=735$ which represents a trigger value for which the value of sunk cost investment equals the value of waiting. That means that if the investment is lower than $I = 735$, the farmer should wait and vice versa.

It should also be noted that the value of flexibility is not always be positive. Postponing an investment decision can for example have additional costs if the investor has competitors. Therefore, the investor must decide if the price of flexibility will surpass its value. The value of real options will therefore be the highest when there is uncertainty, when they have the option to exercise flexibility and the NPV value is near zero (Antikarov & Copeland, 2003).

2.2 Problem description

This thesis will make use of the real option approach to investigate how political risk influences the agricultural sector. According to (Antikarov & Copeland, 2003) and Dixit and Pindyck (1994), there will be a real option to wait if the following characteristics of investment are present: (i) uncertainty about future payoffs; (ii) the ability to choose the optimal timing of investment; and (iii) investment decisions are at least partially irreversible. According to Dixit and Pindyck, an increase in risk will increase the real option value of investment, which will make firms more cautious. Firms will then prefer to wait and see, rather than to invest under uncertain circumstances (i.e. optioning to wait).⁹ I would argue that the characteristics put forth by Dixit and Pindyck is applicable for farmers' investment decisions because (i) Parliament can influence farmers' profits through target prices, transfers and more.¹⁰ (ii) In many cases, the option to delay investment will be feasible, at least for a little while. (iii) Many investment decisions in agriculture are firm specific and sunk cost. If a farmer builds a new barn, the investment cost cannot be recovered and is therefore sunk cost.

Here the real option theory will be tested against data on investment in the agricultural sector. The purpose of this is to see if one can identify the "wait and see" effect predicted by option theory, during periods of increased political risk. Uncertainty in this paper is associated with fluctuations in political risk represented by general elections and the election of new governments. This uncertainty creates an opportunity cost of investing today, which is not included in the traditional net present value analysis (NPV). The opportunity cost arises because the timing of investment can affect farmers' revenues. The farmer may be able to increase his revenue by postponing an investment decision during periods of increased political risk. It is this predicted delay in investment I will try to find evidence for.

⁹ Uncertainty and Investment Dynamics (2001) By Bloom, Bond and Van Reenen

¹⁰ See section 1.4 for more on political governance in agriculture.

3 Data and method

3.1 Data from Norwegian National Account

The Norwegian National Accounts (Nasjonalregnskapet) offers quarterly data that allow us to analyse the effect of timing on investment. According to option theory, the option value will increase prior to an election and the quarterly data allow to study whether there is empirical evidence of this predicted drop in investment.

The data used in this analysis, are quarterly time-series data from 1970-2013, downloaded from the SSB website table 09183 and is in current prices of mill. NOK. The data are calculated using the latest available final account year. This final account year is then used as a benchmark to calculate investment in the later periods¹¹. Numbers are further developed with monthly economic indicator variables for volume and price development in investment provided by the Budget Committee for Agriculture (Budsjettnemnda for Jordbruk). Thus, the quarterly numbers are based on a combination of information from the benchmark year and development in investment after the benchmark year.

In order to find the effect of risk on investment, control variables for important determinants of investment are included. The control variables in this model are: aggregate demand given by Y and the interest rate, given by R .

The business cycle significantly influences investment demand. The reason for this is that during periods of economic expansion, we will adjust our expectations of future disposable income and expect a higher disposable income in the future. With a higher disposable income, demand increases for both consumption goods and investment. When disposable income increases, profit for businesses also increase, making it easier for businesses to finance new investments than when profits are low.

In addition, during a recession there may also be greater uncertainty as no one knows when the recession will end. It is therefore assumed that private investment is heavily dependent on

¹¹ For example if you use 2010 as a benchmark, then all four quarters in 2011 and 2012 will be benchmarked against 2010 numbers. In addition, the preliminary numbers published for the first, second and third quarters in 2013 will be benchmarked against 2010 and it is only after the publication of 2011 numbers in November 2013, that 2011 numbers can be used as a benchmark.

aggregate demand and that demand varies with the business cycle. Aggregate demand has here been proxied by non-oil GDP downloaded from the SSB website (table 09190) and the data are in current prices of mill NOK for the years 1970-2013.

The real interest rate is also an important determinant of investment. The reason for this is that it represents the alternative cost of capital. If, one decides to keep money in the bank instead of investing, that money will earn an interest. One who decides to invest therefore foregoes this increase in value represented by the real interest rate. The value of the alternative cost should therefore be included when deciding whether to invest or save money. This means that when interest rates are low, the alternative cost of investment is lower – giving a higher investment demand. Data on the real interest rate can be downloaded from SSB yearbook on (Statistics Norway)¹².

The dependent variable in this thesis is investment for farmers. The model controls for standard variables influencing investment, but I will also control for variables influencing investment in agriculture specifically. A change in the budgetary frame for the agricultural negotiations, given by BF¹³ in the equation, is such a variable. The budgetary frame will influence farmers' incomes directly through prices and transfers and they can give incentives for increased investment.

It is also expected that changes in the budgetary frame (i.e. transfers) and political risk are correlated. The reason for this is that political risk is a representation of farmers' unobservable expectations. If farmers are experiencing increased risk, this can be because they fear that transfers may be reduced in the budgetary frame in the future. Many factors can influence the perception of risk, but the general election of 2013 might exemplify this in a good way. In 2013, the Progress Party (FRP) was elected into government together with the Conservative Party (Høyre). Both parties' policies on agriculture are aimed at reducing agriculture's dependency on state funding. It would therefore be rational for farmers to expect lower transfers in the future (i.e. increased risk). For the election of 2009 on the other hand, the Center Party (SP) was re-elected into government. The Center Party's policies are aimed at securing food production throughout Norway, so it is less likely that they will reduce

¹² <http://www.ssb.no/a/aarbok/tab/tab-454.html>

¹³ For more information on the budgetary frame, see Appendix A.

transfers.¹⁴ By adding a variable that controls for changes in the budgetary frame, I will be able to separate the *effect of risk*, and the *effect of transfers*¹⁵ on investment. If we do not control for BF, the effect of government transfers will be included in the effect risk has on investment inflating the estimate.

The regression also includes a set of seasonal dummies for the quarterly National Account. Production in agriculture is seasonally dependent and it is therefore likely that investment will be seasonal also.

The basic econometric model to be estimated here is:

$$\text{Investment} = \alpha + Y + R + \text{BF} + \delta_1 \text{Election} + \delta_2 \text{Government} + q_1 + q_2 + q_3 + \epsilon \quad 3.1)$$

Where α is the constant, Y is production, R is the interest rate, BF is the budgetary frame in the agricultural negotiations, q_1 - q_3 are seasonal dummies and $\delta_1 \text{Election}$ and $\delta_2 \text{Government}$ are intercept dummies for political risk. A change in investment according to this model is therefore a result of a set of standard explanatory variables for investment and a set of dummy variables and a summary of the data is provided in table 1.

Table1: Description of variables.

. sum Investment Production Interestrate Government Election Budgetaryframe					
Variable	Obs	Mean	Std. Dev.	Min	Max
Investment	144	1424.215	430.1696	695	2617
Production	144	250860.2	153251.6	49744	606495
Interestrate	140	5.594286	3.027732	-.4	12
Government	144	.0763889	.2665464	0	1
Election	144	.0625	.2429064	0	1
Budgetaryframe	143	840.5734	792.7356	-1650	1900
.					

The variables $\delta_1 \text{Election}$ and $\delta_2 \text{Government}$ in the above equation are the main variables of interest. The variables are so-called intercept dummies that create a parallel shift in the equation when the dummy is equal to one. If the hypothesis in this thesis is true and political

¹⁴ Some would argue that the correlation between parties and transfers is not as clean cut as it is portrayed in this thesis. However, the main argument made here is that there is a correlation between political risk and government transfers.

¹⁵ For more information on the data on producer support, please see Appendix 7.1.

risk does influence producer behaviour, I would expect a negative shift in investment when $\delta_{1\text{Election}}=1$.

3.1.1 ARCH(1) model estimation.

In order to estimate the effect of risk on investment I have chosen to use the autoregressive conditional heteroscedastic (ARCH(1)) model and the following section is based on the framework of Hill, Griffiths, & Lim, the work of Sayed Hossain at the Hossain Academy (Hossain, u.d.) and Robert Engle's article GARCH 101.

The ARCH model will estimate the volatility (i.e. the standard deviation) of investment. If a farmer options to delay - investment will decline before an election and this delay will increase the variance. After uncertainty is resolved, the farmer can choose to increase or reduce aggregate investment. This decision, to either increase or reduce investment, will also influence the variance. There may therefore also be valuable information on option values in the variance.

The ARCH model is especially useful for modelling volatility and changes in volatility over time (Hill, Griffiths, & Lim, Principles of econometrics , third edition, 2007). As risk can be measured as an increase in the standard deviation of investment (i.e. volatility), the ARCH model is a natural selection for our purpose.

In order for the ARCH model to be applicable for our analysis two preconditions must be met:

1. There must be clustering volatility in the residual
2. There must be an ARCH effect in the residual

1) Clustering volatility

Clustering means that a period of high volatility is followed by another period of high volatility. While low volatility is followed by other periods of low volatility, for a prolonged period. If such an effect can be identified, we have clustering volatility. To illustrate the effect of variations in volatility I have plotted the residuals of the regression over time in Figure 2. We see that there are rapid changes in the residuals, so the data does exhibit volatility. In

addition, there is evidence of clustering volatility. If we look at the period 1961-1965 for example, there are periods of low volatility followed by low volatility. The period 1990-1995 on the other hand, have periods of high volatility following high volatility. Therefore, the condition for clustering is met.

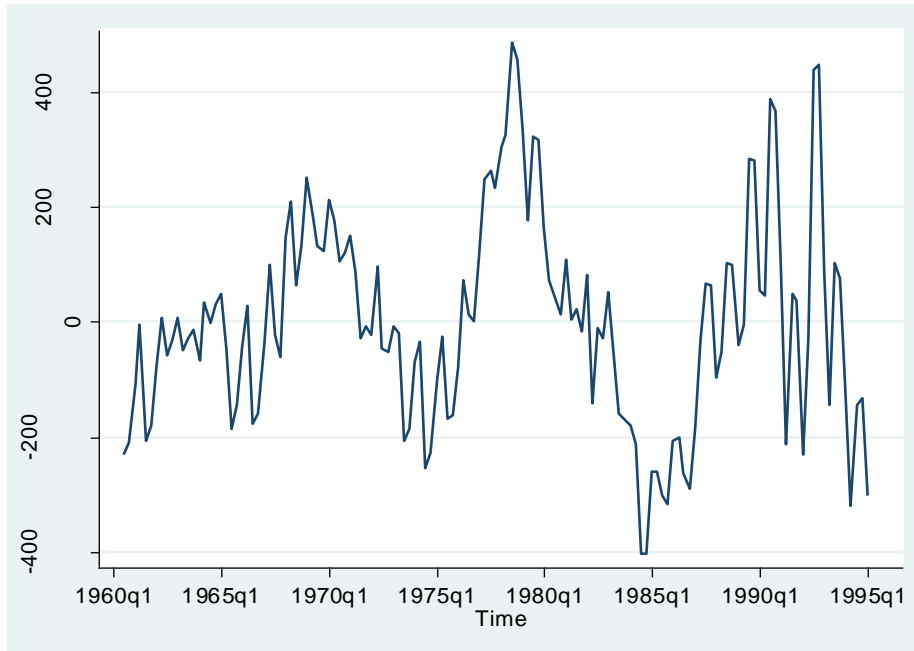


Figure 2 Residuals from the fitted values of the regression over time.

2) The second condition is that we must have an ARCH effect in the residual. To test for this we will use the Lagrange multiplier (LM) test in Stata.

To perform the test we must first estimate equation 3.1 to obtain the estimated residuals R_t . The residuals R_t are conditional on the residual lagged R_{t-1} (i.e. heteroscedasticity) and are a linear function of the residuals squared R_{t-1}^2 (Kennedy, 2008). Stata has performed this test for us and the results are reported below.

Table 2: Lagrange Multiplier test for ARCH effects

<pre>. estat archlm, lags(1)</pre>			
LM test for autoregressive conditional heteroskedasticity (ARCH)			
lags (p)	chi2	df	Prob > chi2
1	45.756	1	0.0000
H0: no ARCH effects vs. H1: ARCH(p) disturbance			

Our null hypothesis is that there are no ARCH effects and the alternative hypothesis is that there are ARCH effects. The Stata output gives us a p-value of 0.000, which is less than 0.005. This implies that we can reject the null hypothesis for all significance levels and the ARCH model can be applied.

The ARCH model consist of two equations, the mean equation and the variance equation. The mean equation is determined by economic theory and describes the behaviour of the variables form the mean in my time-series. The variance equation will describe investment today as a result of the mean value of investment today plus the standard deviation of investment (i.e. the square root of the variance) times the error for the present period.

Mean equation:

$$\text{Investment} = \alpha_1 + Y + R + q_1 + q_2 + q_3 + \varepsilon \quad 3.2)$$

Here we see investment as a function of a constant, production, the interest rate, seasonal dummies and the residual.

Variance equation:

$$V = \alpha_2 + R_{t-1}^2 + BF + \delta_1 \text{Election} + \delta_2 \text{Government} + \varepsilon \quad 3.3)$$

Here V is the variance of the residual derived from mean equation (3.2) while R_{t-1}^2 is the previous periods squared residual known as the ARCH term. This term represents the internal shock that influences the volatility of investment. The variables BF, $\delta_1 \text{Election}$, $\delta_2 \text{Government}$ represents external or predetermined shocks that influence the volatility of investment. The mean equation (3.2) and variance equation (3.3) are then estimated simultaneously using the maximum likelihood method and the output is reported in section 4.1

3.1.2 Alternative specification.

The general model to be estimated here exhibits autocorrelation and heteroscedasticity. One therefore has to decide if one wants to take advantage of this information in modelling or if

inference can be improved by applying other estimators. Instead of considering heteroscedasticity to be a problem that should be corrected, the ARCH model treats heteroscedasticity as a variance that should be modelled. In the previous section, the variance of investment was modelled because the Lagrange multiplier test indicated that we have an ARCH effect. However, the Lagrange multiplier test for ARCH can also be viewed as a misspecification test. Even though, the Lagrange multiplier test indicates that the presence of ARCH this could also be caused by the result of other misspecifications given by for example omitted variable bias. In order to verify the results from the ARCH model specification, I will try an alternative specification using ordinary least square regression (OLS). The least square regression does not model the variance of investment in the way that the ARCH model does. Instead, the least square regression estimates if the dummy variables for risk significantly influences *the level* of investment. While the results from ARCH and OLS are not directly comparable, estimating both the volatility of investment and the investment level will give us more information on the potential effect of risk on investment than if we just used one estimation method.

The assumptions of the least square regression are discussed in Appendix A (section 6.1.1), but it should be noted that there is autocorrelation and heteroscedasticity so robust standard errors are applied.

$$\text{Investment} = \alpha + Y + R_{t-1} + BF + \delta_1 \text{Election} + \delta_2 \text{Government} + q_1 + q_2 + q_3 + \epsilon \quad 3.4)$$

The basic econometric model to be estimated here is the same model as the one specified in section 3.1, but with a few minor changes. Firstly, I will include a lagged variable for the interest rate to account for the fact that it takes some time for the interest rate to influence the economy. This also had the model a better fit for the least square assumptions.

Secondly, I have added a quarter to each of the dummy variables. The benefit of increasing the time-interval is that I am able to include more risk averse farmers in the regression. While some farmers will only option to delay an investment for one quarter, others will be more risk averse, optioning to wait for two quarters. Therefore, I will include more risk averse farmers in the regression by increasing the time-interval. However, there is also a down side. By increasing, the time interval where the dummy variable is equal to one, I will also increase the probability that there will be other factors than the election influencing the option value. Because when we look at a longer time interval it is likely that there will be other events that

potentially can influence the investment level. In spite of this, I have chosen to increase the time-interval so the hypothesis that risk influences investment will be tested on data for three months (i.e. quarter), six months in this specification.

In summary, in the least square regression I will let the dummy variable represent the quarter *before* the election, and the quarter *of* the election. In addition, to account for the fact that there may be uncertainty for a longer period than one quarter when a new government is elected, I have included the quarter *after* a new government is elected. This uncertainty could be given by for example the option to wait until the agricultural negotiations. To illustrate the difference between the dummy variables in the ARCH model and the OLS regression I have included a figure that is reported below.

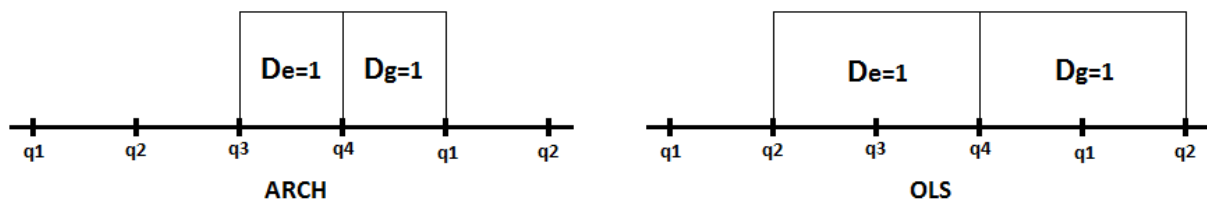


Figure 3: Difference between dummy variables in the ARCH model and OLS specification.

3.2 Aggregated Account for Agriculture.

Option values might vary with the time-horizon and the depreciation rate. For data on investment, I would expect to see a larger option value for investment decisions where the depreciation rate is larger and where the time-horizon for the investment decision is shorter (i.e. machines). The main variables of interest in this model are the dummy variables for risk given by general elections and the election of new governments. While a new government, theoretically, can be elected at any point in time, general elections are held every four years. If general elections represent an increase in political risk I would therefore expect to see a larger option value, on four year investment decisions, than on investments with a 15-20 year life span. To analyse if option values vary with time-horizon and the depreciation rate, I have chosen to look at data for the Aggregated Accounts for Agriculture (Totalkalkylen) table

310C (buildings) and 310D (machines)¹⁶ published by NILF in current prices NOK for the years 1959-2013.¹⁷

Two models will be estimated here: one for investment in machinery and one for investment in buildings. In section 3.1. I tested the hypothesis that that political risk influenced investment by applying an ARCH model and by ordinary least square regression. The Lagrange Multiplier test for ARCH effects is not significant for the Aggregated Account for Agriculture, so in this section I will only apply the ordinary least squares regression. Meaning that in the analysis on the Aggregated Account I will *not* look at the volatility of investment. I will only look at how the investment level is influenced by an increase in political risk.

The models here are variations of the model estimated in the previous section, but with some minor modifications. In order to improve the fit, a lagged interest rate has been included in both models. In addition, as these data are annual, seasonal dummies are no longer appropriate and have been excluded. In the investment model for buildings, there was a right skewed distribution and in order to improve the fit I squared the variable for production so that the OLS assumptions would.

The data sources used in calculating investment in buildings and machinery differs, and a description of each individual dataset is included in the next section. Also, the model will apply the same control variables as in previous specifications. Data on GDP has been downloaded from the SSB website table 09842 and is in current prices NOK per capita. Data on the real interest rate, on the other hand, has been downloaded from the SSB yearbook¹⁸.

For the investment in machinery model, I have also included a control variable for the value of Norwegian kroner (NOK). The reason for this is that Norway does not produce agricultural machinery and most equipment is imported. Therefore, if NOK appreciates against, for example American dollars, then farmers buying tractors in dollars will have to spend less NOK to get a tractor. It is therefore expected that the currency and import statistics are positively correlated and NOK is included in equation (3.6). The data for the exchange rate is available on the central bank webpage¹⁹ and for the purpose of this thesis; I have chosen to

¹⁶ http://www.nilf.no/statistikk/totalkalkylen/2013_1/BMgrupper/Totalkalkylen-Bruttoinvest_Lopende_priser

¹⁷ Information and data description in this section has been based on the publication for the Aggregated Account pages 105-110. (Budsjettnemnda for jordbruket, 2013)

¹⁸ <http://www.ssb.no/a/aarbok/tab/tab-454.html>

¹⁹ <http://www.norges-bank.no/no/prisstabilitet/valutakurser/>

look at the I-44 index, which gives a yearly average of the value of NOK weighted against the yearly average of the currency in 44 other countries.

3.2.1 Investment in buildings

The data source for investment in buildings is based on the Sample Survey of Agriculture and Forestry. The surveys are conducted by Statistics Norway and were last performed in 2012. These data suffer from the same type of bias as the data in the National Accounts, as data are estimated. This is levied by the fact that data is further developed by information from the Farm Account described in section 3.3, but information on option values can still be lost in the aggregate. It should also be noted, that the data in the Aggregated Account are only based on investment in *new* buildings and repairs of buildings are not included.

To test the hypothesis that political risk influences investment in buildings, ordinary least squares estimate has been performed on equation (3.5). The assumptions for the OLS regression are discussed in section 6.1.2, but it should be noted that the assumption of autocorrelation is violated. Robust standard errors are therefore applied and the results are reported in section 4.2.

$$\text{Invest buildings} = \alpha + Y^2 + R_{t-1} + BF + \delta_1 \text{Election} + \delta_2 \text{Government} + \epsilon \quad 3.5)$$

3.2.2 Investment in machines

The Aggregated Accounts for Agriculture offer data on investment in machinery and equipment. These data are mainly based on information on import of machinery, sale statistics from dealers and first time registration of motorized vehicles (Motorvognregisteret) (Budsjettnemnda for jordbruket, 2013). As data on investment in machinery are real, annual numbers instead of annual estimates it is reasonable to believe that option values will be better preserved and that data on machinery will be better suited for analysing short-term fluctuations in investment. To test the hypothesis that political risk influences investment a regression analysis has been performed on equation (3.6) and the results are reported in section 4.2.1:

$$\text{Invest machinery} = \alpha + Y + R_{t-1} + \text{NOK} + \text{BF} + \delta_1 \text{Election} + \delta_2 \text{Government} + \epsilon \quad 3.6)$$

3.3 The Farm Account Data

Data on the Farm Account (driftsgranskning) data, are panel data available for the years 1991-2012 and have been supplied by Eva Øvren at NILF. The Farm Account data are annual surveys conducted by NILF. Surveys are quite thorough and they provide detailed information on Norwegian agriculture based on farmers' tax accounts. These data do not suffer from the same bias as the data from the Aggregated Accounts or the National Accounts, which estimates investment on a variety of sources. The data from the Farm Account data are farmers' tax accounts on how much they *actually* invested and what they invested in. Option values should therefore be well preserved in this data set.

There are some issues in using these data in the regression²⁰. Firstly, the sample is not random. Participants are chosen from a database of farmers applying for production subsidies from the Norwegian Agricultural Authorities (Statens Landbruksforvaltning), but not all farmers are allowed to participate. Only farmers of a certain size are invited to take part and the official criteria for the 2012 survey was that farmers had to have a gross margin of at least 8 European Size Units (ESU), where one unit ESU=Euro 1200. In other words, farmers invited to participate had to have a gross margin of at least Euro 9600 or about NOK 75,000. In addition, surveys are quite comprehensive and time-consuming so not all farmers who are invited want to participate. These issues can bias the regression because it might be that farmers on larger farms respond to risk differently than farmers with small farms. There may also be differences between farmers that choose to participate in the surveys and those that do not. It should also be mentioned that the sample size for the data in this analysis was N=100 in 2013, but the sample size is not constant. The rest of the econometric specification follows the same framework as in section 3.1- 3.2.

²⁰ The information on the The Accounting Survey have been found in the 2012 publication of the The Accounting Survey (NILF, 2012).

3.3.1 Sector specific investment

To analyse the effect of risk in one specific sector I have chosen to look at sheep farmers' investment behaviour. This sector has been chosen because production terms have been relatively stable compared to other sectors. The general model to be estimated is given by (3.7) and the results are reported in section 4.3. The model has only been estimated using least square regression analysis as the Lagrange Multiplier test for ARCH effect is not significant. I am therefore not able to analyse the volatility of investment in this section. I am only able to analyse if political risk influences the investment level:

$$\text{Investment} = \alpha + Y + R_{t-1} + BF + \delta_1 \text{Election} + \delta_2 \text{Government} + \epsilon \quad (3.7)$$

4 Results

4.1 Results ARCH model

The foundation for the ARCH model is centered on the variance of the model. By removing the trend from the variables of the mean equation, it analysis to what extent the variance of the model can be explained by the exogenous shocks of the model. The first part of the Stata output gives us the mean model. We see that all control variables are important determinants of investment at the 2% significance level, which indicates a strong correlation in the statistical sense. We see that investment is not heavily dependent on aggregate demand as predicted by economic theory. The coefficient for production is only ≈ 0.002 . Though it does have a narrow confidence level, and low p-value. The coefficient for the interest rate on the other hand is much larger. This indicates that when the interest rate is increased by one, investment in agriculture will be reduced by approximately 18. Mill NOK. The seasonal dummies also profoundly influences investment. There can be several reasons for this. Investment in agriculture is heavily seasonally dependent because of the agricultural process, growing season and so on. However, the seasonal dummies can also have an alternative interpretation. In the second quarter of every year, Norway holds its agricultural negotiations and there will always be uncertainty related to the outcome of these. As the negotiations are held every year, it is not possible to control for the timing of these directly. On the other hand, the Stata output does display a reduction in investment in the first quarter (i.e. in the quarter before the negotiations) and an increase in investment after the negotiations (i.e. the second quarter). These results are in line with the hypothesis that a farmer will option to wait to find out more about the budgetary frame before investing.

The second and third part of the Stata output, marked as HET and ARCH gives us the variance equation from equation (3.3). Here HET represents the standard deviation of investment (i.e. volatility). To find out if the variables are significant in explaining the volatility of investment we look at the p-value. The largest p-value here is for the variable that indicates the change in the budgetary frame. This p-value is 0.689, which is very high. Meaning that the variable is not significant at any significance level. This can also be seen by looking at the confidence interval, which is very wide. This is quite surprising, as one would

expect increases in the budgetary frame to increase investment. The lowest p-value of the regression is 0.152, which is more than 0.10, meaning that the dummy variable for elections is not significant in explaining the volatility of investment at the 10% significance level. The coefficient for elections is negative, which is consistent with the hypothesis that investment falls when risk increases, but because the confidence interval is quite broad, we cannot be confident that elections and investment are negatively correlated. In summary, none of the variables for risk significantly influences the volatility of investment in a statistical sense.

Lastly, we look at the ARCH effect. The ARCH effect has a p-value 0.039, which is less than 0.05, meaning that the ARCH effect is significant in explaining the volatility of investment at the 0.05 significance level. This means that the previous periods residuals does influence volatility of investment today.

Table 3: Results ARCH model estimation.

ARCH family regression -- multiplicative heteroskedasticity						
Sample: 1960q3 - 1995q1			Number of obs		=	139
Distribution: Gaussian			Wald chi2(5)		=	1391.87
Log likelihood = -901.1006			Prob > chi2		=	0.0000
Investment	OPG		z	P> z	[95% Conf. Interval]	
	Coef.	Std. Err.				
Investment						
Production	.001664	.0000839	19.84	0.000	.0014996	.0018284
Interestrates	-17.93673	3.573598	-5.02	0.000	-24.94086	-10.93261
SeasonQ1	-314.5556	34.44827	-9.13	0.000	-382.073	-247.0382
SeasonQ2	438.2942	29.33061	14.94	0.000	380.8073	495.7811
SeasonQ3	366.115	27.89207	13.13	0.000	311.4475	420.7825
_cons	1019.427	47.5995	21.42	0.000	926.1338	1112.72
HET						
Government	-1.914528	1.48924	-1.29	0.199	-4.833384	1.004328
Election	-5.604441	3.909705	-1.43	0.152	-13.26732	2.058439
Budgetaryfr~e	-.0001106	.0002767	-0.40	0.689	-.000653	.0004318
_cons	9.918891	.39476	25.13	0.000	9.145176	10.69261
ARCH						
arch						
L1.	.572167	.2746979	2.08	0.037	.0337689	1.110565

4.1.1 Alternative specification of ARCH

The ARCH model specification did not yield significant results for the dummy variables for risk, but this could potentially be the result of the model specification. An alternative specification is therefore introduced and the results are presented in table 4.

Table 4: Results OLS specification for the quarterly Norwegian National Account.

<pre>. regress Investment Production L.Interestrates SesongQ2 SesongQ1 SesongQ3 BF Gov > ernment Election, vce(hc3)</pre>						
Linear regression			Number of obs = 140 F(8, 131) = 67.36 Prob > F = 0.0000 R-squared = 0.8116 Root MSE = 189.66			
Investment	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
Production	.0015867	.0001243	12.76	0.000	.0013407	.0018326
Interestrates L1.	-15.48202	4.449941	-3.48	0.001	-24.28506	-6.678973
SesongQ2	425.7019	50.63781	8.41	0.000	325.5282	525.8756
SesongQ1	-326.4212	39.24611	-8.32	0.000	-404.0594	-248.783
SesongQ3	356.1245	49.84606	7.14	0.000	257.5171	454.7319
BF	.0378662	.0221868	1.71	0.090	-.0060246	.0817569
Government	50.22227	37.21352	1.35	0.179	-23.39495	123.8395
Election	9.482937	51.47222	0.18	0.854	-92.34139	111.3073
_cons	962.6709	60.72644	15.85	0.000	842.5396	1082.802

The results from the ordinary least squares regression are quite different from the results obtained in the ARCH model estimation. The p-value for the intercept dummy for governments is ≈ 0.18 , which is more than 0.10, meaning that the election of a new government is insignificant in explaining investment at the 10% level. In addition, the sign of the coefficient has changed. Since the confidence level is broad too much emphasis cannot be put on this, but it does indicate that the sign of the coefficient is unstable across specifications. The dummy variable for elections in the ARCH model had a p-value of 0.152. In the least squares regression, the p-value is 0.854, which is much higher. Meaning that elections are not significant in explaining either the volatility of investment or the investment level. The results from the least squares regression is quite different than the results from the ARCH model

specification, still both specifications reject the hypothesis that risk significantly influences investment.

4.2 Results Aggregated Account buildings.

Table 5: Result from OLS regression on data on annual investment in buildings.

. regress Investment Prod2 L.Interest Budgetaryframe DummyG DummyE, robust						
Linear regression			Number of obs = 34			
			F(5, 28) = 23.10			
			Prob > F = 0.0000			
			R-squared = 0.7678			
			Root MSE = 3.4e+05			
Investment	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
Prod2	5.39e-06	6.29e-07	8.57	0.000	4.10e-06	6.68e-06
Interest L1.	23410.78	25948.09	0.90	0.375	-29741.48	76563.04
Budgetaryframe	242.3199	73.37378	3.30	0.003	92.02053	392.6193
DummyG	-103112.6	169710.1	-0.61	0.548	-450748	244522.8
DummyE	22844.19	177093	0.13	0.898	-339914.4	385602.7
_cons	982839.3	237029	4.15	0.000	497307.4	1468371

To interpret the results of the regression I will look at the p-value and confidence interval for the regressors. The results indicate that both production and the budgetary frame are significant in explaining investment. Production has a p-value of 0.000, while the budgetary frame has a p-value of 0.003, which is less than 0.005. Meaning that both production and the budgetary frame are significant in explaining investment at the 5% level.

The weakest test statistics of the regression is obtained for the dummy on elections. The election dummy has a p-value of 0.898, which is considerably higher than 0.005, meaning that we can thoroughly refuse the hypothesis that the elections influence investment in buildings at the 5% significance level and all other reasonable significance levels.

The results also indicate that the sign of the coefficient for the elections variable is unstable. In the ARCH model we saw that the results gave non-significant results with *negative*

coefficients, while the least squares estimates have given a non-significant *positive* coefficient. However, the maximum likelihood estimation from the ARCH model was performed on quarterly data and the least squares estimates are performed on annual data. The positive coefficient for elections can therefore be picking up an increase in investment in the time after the election. Still, the p-value for elections is quite high and the confidence interval quite broad, so too much emphasis should not be put on this result.

The second weakest test statistic of the regression is obtained for the dummy variable new governments, which has a p-value of 0.548. That is considerably higher than 0.005, meaning the new governments does not influence investment in new buildings in the statistical sense.

4.2.1 Results Aggregated Account machines.

Table 6: Result from OLS regression on data on annual investment in machines

. reg Investment Production L.interest NOK Budgetaryframe DummyG DummyE						
Source	SS	df	MS	Number of obs = 34		
Model	1.9126e+12	6	3.1877e+11	F(6, 27) = 3.43		
Residual	2.5106e+12	27	9.2984e+10	Prob > F = 0.0120		
Total	4.4232e+12	33	1.3404e+11	R-squared = 0.4324		
				Adj R-squared = 0.3063		
				Root MSE = 3.0e+05		
Investment	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
Production	1.047222	.3709961	2.82	0.009	.2860013	1.808444
interest						
L1.	-58157.62	32091.48	-1.81	0.081	-124003.9	7688.659
NOK	44295.33	16474.53	2.69	0.012	10492.39	78098.26
Budgetaryframe	73.58518	82.63345	0.89	0.381	-95.96465	243.135
DummyG	191365.5	145314	1.32	0.199	-106794.1	489525.1
DummyE	-189312	142543.1	-1.33	0.195	-481786.3	103162.2
_cons	-1918274	1476688	-1.30	0.205	-4948187	1111639
.						

The results obtained in the second specification for the Aggregated Account, indicate that the variable for production is significant in explaining investment in agricultural machinery at the 10% significance level and NOK is significant in explaining investment at a 15% significance level.

A surprising result is obtained for the variable for changes in the budgetary frame. The budgetary frame was significant at a 5% significance level for investment in buildings, but it is not significant for any reasonable significance level for investment in machines with a p-value of 0.381. This means that farmers do not go out and buy a new tractor if the budgetary frame increases. They may however, decide to build a new barn if they believe that production terms will be improved.

In section 3.2 of this paper, I theorized that option values might vary with the depreciation rate and the time-horizon of investment. The results of the regression indicate that this could be true. Though both dummy variables for risk are insignificant, we do see a considerable difference in the test statistic between investment in machines and in buildings on our dummy variables. While the p-value for general elections on investment in buildings is 0.898 - the p-value for machines is 0.195, which is considerably lower.

This result also holds for the dummy variable for a new government. Here the p-value for the dummy variable on new governments was 0.548 for investment in buildings, and 0.199 for investment in machines. Though all the coefficients on the variables for risk are insignificant there does seem to be an effect of the depreciation rate on the option values for investment.

4.3 Results Farm Account data

Table 7: Result from OLS regression on data for sheep farmers' annual investment.

. regress Investment Production L1.interest BF DummyG DummyE						
Source	SS	df	MS	Number of obs = 21		
Model	2.8491e+14	5	5.6981e+13	F(5, 15) = 22.26		
Residual	3.8402e+13	15	2.5601e+12	Prob > F = 0.0000		
				R-squared = 0.8812		
				Adj R-squared = 0.8416		
Total	3.2331e+14	20	1.6165e+13	Root MSE = 1.6e+06		
Investment	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
Production	25.14184	4.37112	5.75	0.000	15.82502	34.45866
L1.interest	134009	261971.1	0.51	0.616	-424369.1	692387.2
BF	959.9834	825.5472	1.16	0.263	-799.6287	2719.596
DummyG	-2197588	1109018	-1.98	0.066	-4561404	166227.4
DummyE	1156899	982756.4	1.18	0.257	-937796.2	3251595
_cons	-4284549	2615502	-1.64	0.122	-9859359	1290261
.						

The dependent variable in this regression is sheep farmers' investment. The results of this regression indicate that production among sheep farmers is dependent on aggregate demand proxied by GDP in the regression. The lagged version of the real interest rate on the other hand is not significant.

The lowest p-value for our dummies on political risk is given by the variable for new governments. This dummy has a p-value of 0.006, which is less than 0.010. Meaning that new governments are significant in explaining investment among sheep farmers at a 10% significance level. This means that in the year were a new government is elected, aggregate investment among sheep farmers is reduced with 2 197 588 NOK. This could be interpreted as farmers optioning to wait before investing to get more information on the political framework. While this is not strongly significant, it does indicate that there might be a small effect of political risk on producer behaviour when new governments are elected.

5 Discussion

5.1 Discussion of regression results

In summary, I have found little evidence for an effect of political risk on investment data and no evidence that political risk significantly influences producer behaviour.

There may be three reasons for this.

- 1) The data sources may not be accurate enough to identify an option to wait value.
- 2) The proxy variables for political risk may be inapplicable.
- 3) Political risk may not be an important risk factor.

1) One could argue that data sources in this thesis are *highly* processed and therefore unsuitable for analysing the effect of political risk on investment. If the data sources are inappropriate, evidence of option values may have been lost in the aggregate. When I first started working on this thesis I believed that the quarterly numbers from the National Account would be best suited to analyse short term variations in risk because they offered data for every quarter. However, as previously explained, these data are based on economic indicator values. Thus, there is a possibility that the reason we do not find evidence of political risk on investment data, is that the information may have been lost during processing.

The data for investment in machines from the Aggregated Accounts should be more precise as they are based on import statistics, sale from dealers and first time registration of vehicles. In these data, we do see a small effect on the dummy variables for risk, but the result is not significant. If data problems are the reason that we do not find a significant effect of risk on investment - then the data on investment in machinery and the account data from sheep farmers should be most reliable. Given that this is true, it is natural to compare the results from these two regressions.

In the regression on investment data from sheep farmers, we saw that the dummy variable for new governments was significant at a 10% significance level with a negative correlation. This is in contrast to the results obtained in the regression analysis on investment in machines, where we saw a positive correlation. It should be noted that the p- value on this dummy was 0.199, and the confidence interval indicates that the sign of the coefficient could be either

positive or negative, but it is important to note that there is a discrepancy between the results of the most reliable data sources on the effect of risk on investment.

The Farm Account could potentially be best suited to analyse the effect of political risk on investment data, because the data are not processed. The data are based on sheep farmers' tax reports and should therefore be a reliable source of actual investment. Researchers should however be careful not to only use data confirming one's hypothesis. All relevant sources of information should be taken into account when discussing a research topic.

2) The proxy variables for risk in this thesis may be inapplicable and there may be other variables that will be a better measure of risk. The data offers no evidence of elections influencing investment and weak significance of the election of new governments in section 4.3.1. One conclusion that could be drawn from this is that, elections are unsuitable for analysing the effect of risk on investment. If parliamentary elections is a bad measure of risk, one could ask the question if there is reason to believe that the election of new governments will be a better measure? I would argue that this could be the case, but I do not believe that this is the problem. An election in itself will not change the political framework, but a new government can. On the other hand, many governments in Norway are minority governments, so government will often have to seek support in parliament in order to achieve majority for their policy. Parliamentary strength is given by general elections and I therefore believe that both instruments should be relevant.

Another potential explanation for general elections not significantly influencing investment is that one election can be very different from another. In the 2009 election there was no united opposition against the incumbent Red-Green government. In the election of 2013, on the other hand, the opposition was more united and elections polls suggested that a new government would be elected. There could potentially be a difference in how farmers' perceived political risk in these two elections. If for example farmers' perceived political risk to be smaller under the 2009 general election, than under the 2013 election, than these dummy variables may not be appropriate measures of risk.

3) The third interpretation of results is that political risk is not an important risk factor in Norwegian agriculture. Risk does not significantly vary and is uncorrelated with partisan strength and parties in government. Long-term production conditions in agriculture vary slowly and are not heavily dependent on parties' strength in Parliament. In Norway, we have

several arrangements that are aimed at giving farmers predictable production terms and these results may indicate that these arrangements are quite effective. The agricultural sector is stable and thoroughly regulated and systems set in place give farmers predictable production terms.

I would argue that there are three arguments that support the conclusion that political risk is *not* an important risk factor in investment.

- The Norwegian referendums on membership in the European Union should represent two distinct time-periods of significant political risk. In the event of a EU membership, Norway would no longer be able to protect agriculture by tariff barriers and restrictions on producer support would be set in place. Given that political risk is a significant risk factor, investment should therefore decline in the time before the referendums. However, this was not the case and if we look at fig. 1 on page 5, we see that investment increased both before the referendum in 1972 and before the referendum in 1994. This suggests that the reason we do not find a significant effect of political risk is not that the proxy variables for risk are inappropriate, but that political risk is actually not an important determinant for investment.
- In this thesis, there are five models with two proxy variables for risk in each specification. While I do find that the election of new governments are weakly significant on a 10 % significance level, I would argue that we cannot attribute too much importance to this result.

For²¹ a 10 % significance level there is a 90 % probability that a variable is insignificant. If we assume that the probabilities of significance are independent, there will be a $0,9^2=81\%$ probability for none of the variables being significant at the 10% significance level in *each* specification. With five specifications and two proxies, we will test the hypothesis ten times. Here the probability of finding a significant proxy will be $0,9^{10}=35\%$. In other words, the probability that we will find one proxy to be significant, in one of the specifications, is higher than the probability that we will find none of the proxies to be significant. The probability that we will find significant results will therefore increase, also for specifications where there is no correlation

²¹ The following section is based on a line of argument drawn up by supervisor Kjell Arne Brekke.

between variables. One weakly significant result for one proxy is therefore not a strong argument for the election of new governments influencing investment.

- In recent years, there has been much debate on how the election of the Progress Party would affect agricultural production and in the election of 2013 the newspapers²² predicted that right wing politics could destroy Norwegian agriculture. How the election of the Progress Party will influence investment will therefore be important. While data on the full effect of this election are not yet available, we do have some information. If we look at data from the Aggregated Accounts on investment in machinery we see that average annual investment during the Red-Green government from 2005 to October 2013 was 2 455 955. While total investment in 2013 was 2 474 200. In other words, the data show a slight increase in investment. While one could argue that the Progress Party was not elected into government before October 2013, voters knew throughout the election year of 2013 that the Progress Party could be elected. Therefore, if farmers associated the election of the Progress Party with a significant increase in risk, it would not be rational for them to increase investment. As these numbers are preliminary, we cannot attribute too much importance to this result. However, I do think that it is important to note several arguments point in the direction that political risk is insignificant.

5.2 Discussion of model specification

According to the Keynesian tradition, investment can be explained by variations in income and the interest rate. The main purpose of this, is to analyse if some part of the variation in investment can be explained by variations risk. The total variation (SST) explained by the model is therefore relevant. Total variation can be divided into two parts. One that is explained by the model, given SSR, and one part that is caused by random deviations SSE. To find out how much of the variation is explained here we will look at R^2 which is given by $R^2 = SSR/SST$.

²² <http://www.nrk.no/sorlandet/mener-bla-politikk-vil-rasere-bygda-1.10874723>

By comparing the R^2 , we see that the R^2 is largest in the analysis for the Farm Account data. Here the R^2 is 0.88, while in comparison it is 0.768 for the model on investment in buildings and 0.4324 for the model of investment in machines. The R^2 from the Farm Account data could be an indication that the specification where political risk was significant was a better fit. However, the R^2 for investment in buildings is also quite high and in this analysis the dummy variable for new governments was not significant and with a p-value of 0.548. It is therefore difficult to draw any definitive conclusion. Based on these criteria, I would argue that the best fits are for the model in section 3.2.1 (investment in buildings) and section 3.3 (Farm Account data).

We also see that there is a difference in significance for our proxy variables with regard to the depreciation rate and when looking the Farm Account data. One interpretation of this is that farmers do experience some risk, but that it does not significantly influence their producer behaviour.

The aim of this thesis was to analyse the effect of political risk on producer behaviour. The regression models do not provide significant support for the hypothesis from a statistical point of view. However, this does not mean that political risk does not play a role for farmers' behaviour. For instance, an extension on this subject could be to analyse if there is correlation between the number of farms closing down production and variables for political risk. One possible solution here could be to analyse the correlation between entry and exit options for data on number of farms that are operational and risk.

5.2.1 Misspecification of the model

A potentially major weakness of this study may be that the model is misspecified in some way. The relationships between risk and investment may be logarithmic or results may suffer from omitted variable problems. To achieve the highest robustness of results, I have used different techniques to estimate the effect of risk on investment. Among them is OLS *with* and *without* robust standard errors and maximum likelihood estimation in the ARCH model.

Yet, this may only partially alleviate the risk of misspecification if the proxy variables chosen are invalid or if information of risk is lost in the process. It might also be that I have not been

fully able to isolate the full effect of political risk. To check if the model is correctly specified I will apply the Ramsey's Reset test in Stata. The null hypothesis in the Ramsey Reset test is that the model is correctly specified while the alternative hypothesis is that the model is misspecified. The Ramsey test for omitted variable reveals that the only model that does not potentially suffer from omitted variable bias is the model for investment in buildings. The Ramsey test in table 9 reveals a p-value of 0.3578, which is more than 0.10, indicating that we cannot reject the null hypothesis that the model is correctly specified. If the model for investment in buildings is indeed the best fit, the results of this regression does not indicate a significant influence of political risk.

Of particular interest is the model specification for investment among sheep farmers in the Farm Account data and this model may suffer from omitted variable bias with a p-value of 0.071. This will mean that we cannot put too much weight on the significance result for election on new governments, because the model may be misspecified.

This might also be a result of the estimation method used. Since I do not have endogenous variation in the right hand variable I have not used instrumental variable (IV) estimation. Instead, I have used a standard proxy variable and ordinary least squares and the IV and OLS methods handle the error term differently. While the instrumental variable approach leaves the unobserved variable in the error term, a proxy variable tries to remove the unobserved variable (i.e. risk) from the error term. In this way, the instrumental variable recognizes the presence of omitted variable and uses an estimation that will account for this. (Schuetze) As the least squares estimation does not recognizes the presence of a possible omitted variable problem, the Ramsey Reset test might be picking up on the presence of a possible omitted variable in the error term, and this could potentially have been resolved by using the instrumental variable approach.

Table 8: Ramsey test section 3.1.2 (Norwegian National Account)

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of Investment
Ho: model has no omitted variables
      F(3, 128) =      7.11
      Prob > F =      0.0002
```

Table 9: Ramsey test section 3.2.1. (Buildings)

<pre>. estat ovtest</pre>	
Ramsey RESET test using powers of the fitted values of Investment	
Ho: model has no omitted variables	
F(3, 24) =	1.13
Prob > F =	0.3578

Table 10: Ramsey test section 3.2.2. (Machines)

<pre>. estat ovtest</pre>	
Ramsey RESET test using powers of the fitted values of Investment	
Ho: model has no omitted variables	
F(3, 25) =	3.51
Prob > F =	0.0298

Table 11: Ramsey test section 3.3.1. (Sheep farmers)

<pre>. estat ovtest</pre>	
Ramsey RESET test using powers of the fitted values of Investment	
Ho: model has no omitted variables	
F(3, 12) =	3.03
Prob > F =	0.0710

6 Conclusion

The purpose of this thesis has been to address political risk in agriculture and to what extent investment decisions in agriculture are influenced by political risk. Real option theory suggests that political risk incurs a positive option value to wait. In line with the theory, a hypothesis has been established, according to which investments in the agricultural sector are lower in periods prior to elections or when a new government is elected. The hypothesis has been tested empirically on four different datasets and with two different econometric specifications. The ARCH model test the hypothesis that political risk influences the volatility of investment in the Norwegian National Account and I find no evidence that it does. The least square regression estimates if political risk influences the investment level. While I do find that the dummy variable for new governments is weakly significant in one of the specifications, I argue that the evidence is unconvincing.

Even if the results do not support the hypothesis, it cannot be rejected either. While I do discuss potential problems such as missing variables, misspecification of the model or poor variables, which may lead me to falsely reject the hypothesis in section five. I find no conclusive evidence for political risk influencing neither the volatility of investment nor the investment level.

In the introduction, I argued that there was a theoretical possibility that political risk had replaced market risk in agriculture- that the level of risk experienced by farmers was the same, but that the source of risk was different. The analysis in this thesis indicates that political risk does not significantly influence producer behaviour in the agricultural sector – at least with the readily available data and less sophisticated models applied in the analysis. I take this as an indication that it is not obvious that political risk has an effect on investment decisions in the agricultural sector. If there was an obvious correlation, the analysis would have revealed some support in favor of the hypothesis.

Nevertheless, it might still be the case that better data and more advanced models would be able to identify some significant relationship between the degree of political risk and investment decisions in agriculture. Hence, more research is required to better understand these questions.

Appendix A: Data on producer support

In this thesis, there are two sources of information on how much economic support a farmer receives. The first data set gives information on how much the budgetary frame for the agricultural negotiations (rammen for budsjettoppgjøret) changes from year to year. These numbers do not therefore give information on absolute producer support received by farmers; it only gives information on how much the budget changes. Data on the budgetary frame is available for the years 1980-2013.

A more accurate representation of the economic agricultural support is given in the OECD Producer Support Estimate (PSE) calculations. The PSE numbers also account for market price support and tax reductions received by farmers, which is not included in the data for the budgetary frame. The Producer Support Estimates are therefore better suited to give information on real world producer support. On the other hand, the PSE numbers are only available from 1996-2012, so it offers a shorter time-series.

To decide on which of the producer support variables should be included, I have looked at the correlation between investment and the two different variables for producer support. The results indicated a correlation between investment and change in the budgetary frame of 0,2047 and a correlation between investment and PSE of 0,2003. The data on the budgetary frame is therefore more closely correlated with investment and have consequently been chosen as the variable to be included in the model. The data on the budgetary frame was also statistically more significant than the PSE numbers offering further support for the choice of variable. My supervisor Klaus Mittenzwei at NILF has provided both the data on the budgetary framework and PSE calculations.

Appendix B: OLS assumptions

6.1.1 OLS assumptions Norwegian National Account

For estimation by OLS to yield unbiased estimates and inference, the following assumptions must be fulfilled. (Wooldridge, 2009).

- (A1) There should be a linear relationship between the dependent and independent variables.
- (A2) Random sampling, i.e. the data sample.
- (A3) There are no perfect linear relationships between the explanatory variables.
- (A4) The expected value of the residual is zero, conditional upon all the explanatory variables
- (A5) The residual displays constant conditional variance.
- (A6) There should not be autocorrelation in the residuals.

Assumption (A1) - (A2) for more information on this I refer to 3.1 on the data sources. In order to analyse (A3) I have performed a sample estimation of the correlations between the independent variables. The numbers reported in the matrix are Pearson correlation coefficient. These coefficients measures the linear dependence between variables by giving it a numerical value between +1 and -1. A coefficient close to 1, indicates a strong positive correlation. While a negative value indicates a negative correlation. Table 11 does not display any perfect linear relationship between explanatory variables.

Table 12: correlation matrix of right hand side variables for the National Account data

```
. pwcorr Production L.Interestrate SesongQ2 SesongQ1 SesongQ3 BF Government Election
> tion
```

	Produc~n	L.Inte~e	SesongQ2	SesongQ1	SesongQ3	BF	Govern~t	Election
Production	1.0000							
L.Interest~e	-0.3359	1.0000						
SesongQ2	-0.0192	0.0000	1.0000					
SesongQ1	-0.0276	0.0000	-0.3333	1.0000				
SesongQ3	-0.0074	0.0000	-0.3333	-0.3333	1.0000			
BF	-0.0909	-0.0848	0.0022	-0.0066	0.0022	1.0000		
Government	-0.0805	-0.0479	-0.1022	0.1704	-0.1931	0.1040	1.0000	
Election	0.0462	-0.0946	0.2182	-0.2182	0.2182	0.0180	-0.0967	1.0000

Assumption (A4) states that the expected value of the residual should be zero conditional on all the explanatory variables. In order to check this I have calculated the mean of the residuals for the fitted values in the data. The calculations give a mean of approximately zero and the assumption is met.

Table 13: Expected value of National Account data

. mean e				
Mean estimation		Number of obs	=	140
	Mean	Std. Err.	[95% Conf. Interval]	
e	-9.12e-08	15.56085	-30.76656	30.76656

To test the variance of residuals (A5) I have chosen to perform a post-regression analysis of the residuals squared, called the Breusch-Pagan test for heteroscedasticity. This test is designed to test the null hypothesis that we have constant variance (i.e. homoscedasticity) against the alternative hypothesis that we have heteroscedasticity. To reject the null hypothesis at a significance level of for example 0.05 we need a p-value below that value. The results are reported in the table below and reveal a p-value 0.0002 indicating that we do have heteroscedasticity.

Table 14: Heteroscedasticity test for National Account data

. hettest				
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity				
Ho: Constant variance				
Variables: fitted values of Investment				
chi2(1)	=	13.45		
Prob > chi2	=	0.0002		

To test for auto-correlation I have applied the alternative Durbin's test and Breusch-Godfrey Lagrange Multiplier test. The test does reveal that we have autocorrelation between investment and production as well as between investment and the interest rate, so robust standard errors must be applied.

Table 15: Autocorrelation test for National Account data

. durbina			
Durbin's alternative test for autocorrelation			
lags (p)	chi2	df	Prob > chi2
1	173.754	1	0.0000
H0: no serial correlation			
. estat bgodfrey			
Breusch-Godfrey LM test for autocorrelation			
lags (p)	chi2	df	Prob > chi2
1	80.083	1	0.0000
H0: no serial correlation			
.			

6.1.2 OLS estimation the Aggregated Account

Assumption (A1) - (A2) for more information on this I refer to 3.2 on the data sources. In order to analyse (A3) I have estimated the Pearson correlation coefficient. Several authors have tried to set guidelines for the interpretation for the coefficient, but there is not agreement on which level of correlation that will bias the interpretation of the model, but estimates vary between 0.7 and 0.9. (Wikipedia). If there is a multicollinearity problem in these data it will be between the interest rate and the Norwegian krone in Table 17. This result is in line with economic theory, so a strong correlation is natural. Dropping one of the variables would eliminate the problem of multicollinearity, but it would also result in a significantly lower R squared. I would argue that both the interest rate and the value of the Norwegian krone are essential to the analysis and make a significant contribution to the overall model. Both the interest rate and the value of the NOK can be important determinants of investment in imported machines so I believe that excluding them would reduce the overall quality of the model. To look further into this I have performed a regression analysis on investment in machines, excluding the NOK. The analysis revealed that the greatest impact of the change of specification was on the significance of changes in the budgetary frame and the interest rate. While this is important on the interpretation for these coefficients, it does not influence the interpretation of the dummy variables for risk. I will therefore disregard the problem of weak collinearity between the interest rate and NOK.

Table 16: Correlation matrix right hand side variables investment in buildings.

. pwcorr Produksjon Realrente Budsjettrammejordbruksoppgjr DummyG DummyE						
	Produk~n	Realre~e	Budsje~r	DummyG	DummyE	
Produksjon	1.0000					
Realrente	0.1224	1.0000				
Budsjettra~r	-0.0027	-0.2237	1.0000			
DummyG	-0.1062	-0.0497	0.1520	1.0000		
DummyE	0.0646	-0.0820	0.0308	0.3609	1.0000	
.						

Table 17: Correlation matrix right hand side variables investment in machines

	Produk~n	interest	NOK	Budsje~r	DummyG	DummyE
Produk~n	1.0000					
interest	0.1663	1.0000				
NOK	0.0627	0.7547	1.0000			
Budsjettra~r	-0.0027	-0.2237	-0.4890	1.0000		
DummyG	-0.1062	-0.0323	0.0689	0.1520	1.0000	
DummyE	0.0646	-0.0640	0.0037	0.0308	0.3609	1.0000

Assumption (A4). The mean of the residual is our best guess for the expected value and the calculations give a mean of -0.0015 for machines and a mean of 0.002 for buildings, which is fairly close to zero. I have also looked at the distribution of the residuals, which are both somewhat rightly skewed, however the deviation is not large and residuals are approximately normally distributed. The distribution of the errors of investment in machines is listed first and errors in buildings is second.

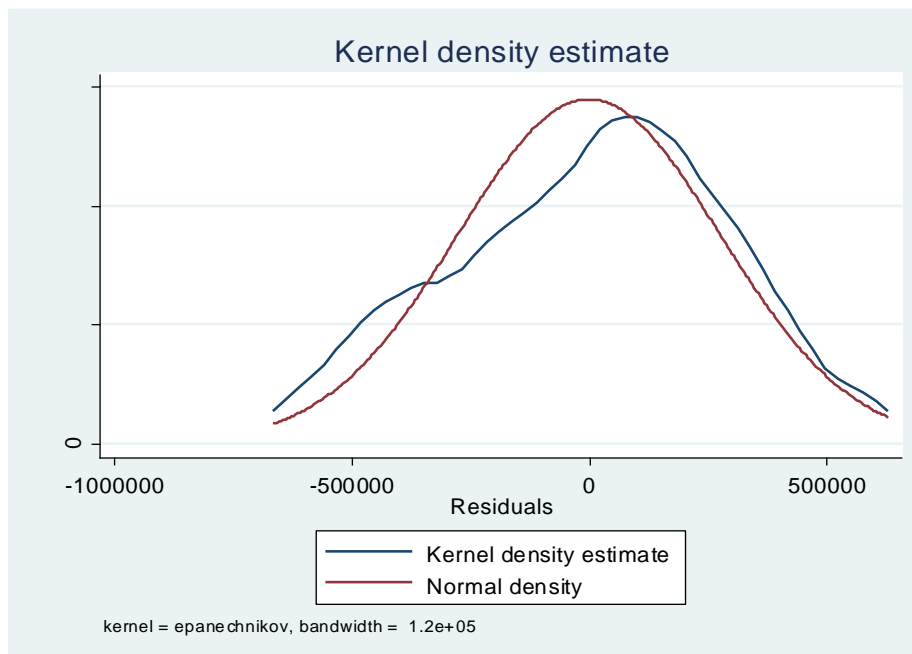


Figure 4: Residuals of fitted regression investment machines

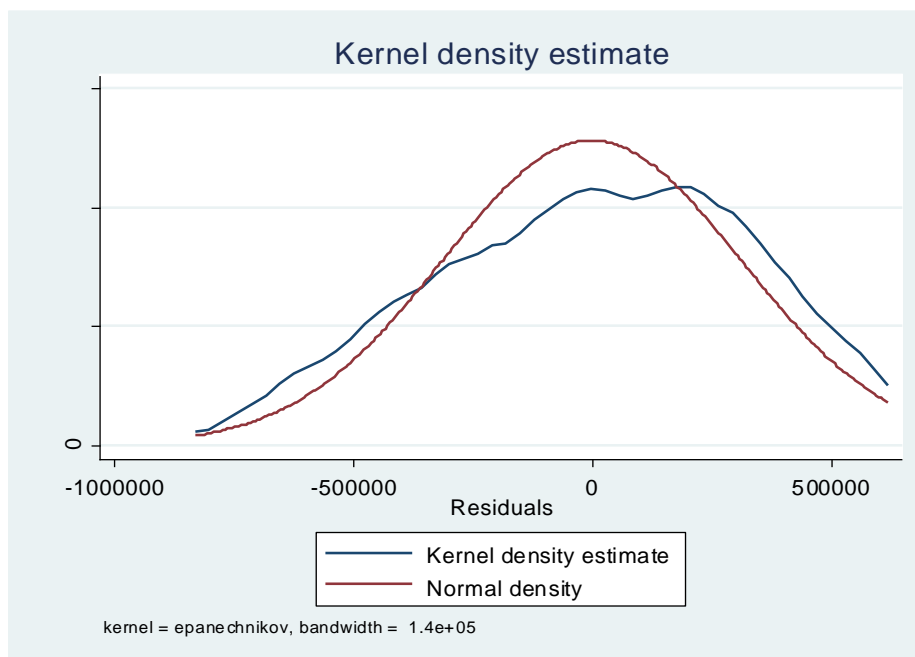


Figure 5: Residuals of fitted regression investment machines

Table 18: Expected value of residuals (proxied by mean) Machines.

. mean e				
Mean estimation		Number of obs	=	34
	Mean	Std. Err.	[95% Conf. Interval]	
e	-.0014505	47303.19	-96239.07	96239.07

Table 19: Expected value of residuals (proxied by mean) Buildings

. mean res				
Mean estimation		Number of obs	=	34
	Mean	Std. Err.	[95% Conf. Interval]	
res	.0019531	53478.27	-108802.4	108802.4

To test the variance of residuals (A5) I have performed a Breusch-Pagan test for heteroscedasticity. The results are reported in the table below and reveal a p-value of 0.8641 for machines and a p-value of 0.7238 for buildings. We can therefore not reject the null hypothesis for any reasonable significance levels and the Breusch-Pagan test for the fitted values of the regression does not display any significant heteroscedasticity.

Table 20: Heteroscedasticity test Machines

. hettest		
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		
Ho: Constant variance		
Variables: fitted values of Investment		
chi2(1)	=	0.03
Prob > chi2	=	0.8641

Table 21: Heteroscedasticity test buildings

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		
Ho: Constant variance		
Variables: Produksjon2 L.Realrente Budsjettrammejordbruksoppgjør DummyG DummyE		
chi2(5)	=	2.85
Prob > chi2	=	0.7238

To test for auto-correlation I have applied the alternative Durbin's test and Breusch-Godfrey Lagrange Multiplier test for autocorrelation. For investment in buildings, we do have autocorrelation between investment and the interest rate. As well as between investment and production. In order to improve the fit I included a lagged version of the interest rate. This can cause identification problems if the interest rate and the lagged interest rate, are too closely correlated. The correlation is 0.7 so the correlation is strong, but there is no perfect collinearity so it should be okay. This modification did not remove the problem of autocorrelation so robust standard errors must be applied.

Table 22: Autocorrelation test Machines

. durbina			
Durbin's alternative test for autocorrelation			
lags (<i>p</i>)	chi2	df	Prob > chi2
1	1.927	1	0.1650
H0: no serial correlation			
. estat bgodfrey			
Breusch-Godfrey LM test for autocorrelation			
lags (<i>p</i>)	chi2	df	Prob > chi2
1	2.347	1	0.1256
H0: no serial correlation			

Table 23: Autocorrelation test Buildings

. durbina			
Durbin's alternative test for autocorrelation			
lags (<i>p</i>)	chi2	df	Prob > chi2
1	10.043	1	0.0015
H0: no serial correlation			
. estat bgodfrey			
Breusch-Godfrey LM test for autocorrelation			
lags (<i>p</i>)	chi2	df	Prob > chi2
1	9.218	1	0.0024
H0: no serial correlation			

6.1.3 OLS assumptions Farm Account data.

Assumption (A1) - (A2) I refer to the discussion in section 3.3. In order to analyse (A3) I have performed a sample estimation of the correlations between the independent variables and the results are reported below. There seem to be no problems of linear correlation between right hand variables.

Table 24: Correlation matrix right hand variables Farm Account data.

	Production	interest	DummyG	DummyE	BF
Production	1.0000				
interest	-0.6698	1.0000			
DummyG	-0.1593	-0.1378	1.0000		
DummyE	-0.0576	-0.2250	0.4824	1.0000	
BF	0.6351	-0.4561	0.2356	-0.0321	1.0000

Assumption (A4) states that the expected value of the residual should be zero conditional on all the explanatory variables. In order to check this I have calculated the mean of the residuals in the data. The calculations give a mean of 0.0045, which is approximately zero, and the assumption is met. I have also applied the Kernel density estimate (pdf) of my residuals to be overlaid with a normal density function. Residuals in our model seem to be approximately normally distributed so the assumption is met.

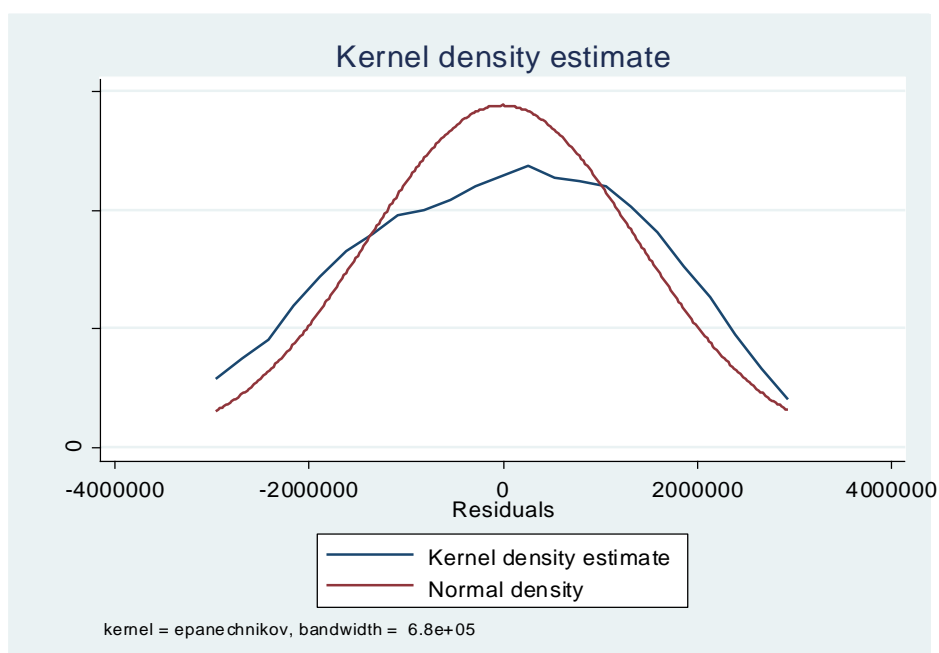


Figure 6: Residuals of fitted regression investment buildings

To test the variance of residuals (A5) I have performed a post-regression Breusch-Pagan test for heteroscedasticity. The results are reported in the tables below and reveal a p-value of 0.8351, indicating that we do not have heteroscedasticity.

Table 25: Heteroscedasticity test

<code>. estat hettest</code>			
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity			
Ho: Constant variance			
Variables: fitted values of Investment			
chi2(1)	=	0.04	
Prob > chi2	=	0.8351	

A(6) When there is a lagged dependent variable the Durbin-Watson test statistic is biased and I have therefore used Durbin's alternative test for autocorrelation and confirmed the results with the Breusch-Godfrey Lagrange Multiplier test for autocorrelation. Both tests reveal that there is no statistical evidence of autocorrelation.

Table 26: Autocorrelation test

Durbin's alternative test for autocorrelation			
lags (p)	chi2	df	Prob > chi2
1	0.010	1	0.9214
H0: no serial correlation			
<code>. estat bgodfrey</code>			
Breusch-Godfrey LM test for autocorrelation			
lags (p)	chi2	df	Prob > chi2
1	0.015	1	0.9038
H0: no serial correlation			

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